Question A1: Factors controlling the yield stress of ccp metals etc: this had been discussed on two or more occasions, therefore your answers were quite disappointing as none of them was complete.

**Grain size**: grain boundaries act as obstacles to dislocation movement. Dislocations form pile-ups against g.b. which later initiate slip in neighbouring grain in order to get full plasticity. Contributes to $\sigma_y \propto d^{1/2}$, i.e small grain size imcrease the yield stress.

**Dislocation density**: dilsocations interact forming locks, sessile dislocations which later join other dislocations. The large no of slip system in ccp means this entanglement form easily. The stress needed to move dislocations therefore rises rapidely with strain, and $\sigma_y$ following cold-work is higher than for a material with lower dislocation density.

**Point defects, intersticial or substitutional solute atoms**: All introduce strain field into the lattice thich interact with strain field of dislocations ond thus impede dislocation motion and raise yield stress.

**Peierls Stress**: intrinsic stress needed to move dislocation through lattice. Depends on width of dislocation core, thus on bonding in metal. Narrower dislocations have higher Peierls Stress.

**Precipitates**: similar effect to dislocation entanglement, can pin dislocation and raise yield stress.

**Effect of shear stress on pined dislocation**: see handout

I don't like the demo of your handout, it does not seem to show why the system becomes unstable and assumes we already have half a circle..

So: consider a segment of the line dl, for a shear stress $\tau$, it is submitted to a force $\mathrm{dF} = \tau b\ \mathrm{dl}$. This is balanced by the line tension: $2\,\mathrm{T}\sin(\mathrm{d}\alpha) \simeq 2\,\mathrm{T}\,\mathrm{d}\alpha$. $R$ being the radius of curvature of the segment and $2\,\mathrm{d}\alpha$ the angle under which it is seen, we have $\mathrm{dl} = 2\,R\,\mathrm{d}\alpha$. We obtain:

$$R = \frac{\mathrm{T}}{\tau b}$$

For a flat segment $R = \infty$, and as we increase the shear stress $\tau$, the radius of curvature becomes smaller and smaller until it reaches L/2, where L is the length of the dislocation.

At this point, replacing T by $\mathrm{G}b^2/2$, we have:

$$\tau = \frac{\mathrm{G}b}{\mathrm{L}}$$

**Mean radius of precipitates** We are told that there is a need for an extra 50 MPa when the precipitates are present. This is to be attributed to the mechanism described before.

So we know the stress required to get the dislocation going :

$$50 \text{ MPa} = \frac{\mathrm{G}b}{\mathrm{L}}$$

This is going to give us the mean distance between 2 precipitates, L. But for this, we need $G$ (given) and $b$.

Mg is h.c.p., therefore $\overrightarrow{b} = [100]$ (slip in basal plane), ie $b = a = 3.21\text{Å}$ (data book).

Fine, we've got $L$, now we need to get the radius.. how do we do ?? We know the volume fraction and the average distance. There we need to assume that the precipitates are uniformly distributed, and imagine that they are distributed on a simple cubic array (that does not affect the mean values under the assumption stated). You remember the number of atoms in a cubic P is one, so we have one spherical precipitate, in average, per cube of side length $L$.

Hey ! We know the volume fraction, and surely, if we have one of these spherical precipitates in a cube of side $L$, it is equal to:

$$\frac{\frac{4\pi r^3}{3}}{L^3}$$

where $r$ is the average radius..